## APPENDIX 5 - STATIONARY AGRICULTURAL IRRIGATION PUMP ENGINES

Below is additional information pertaining to the Stationary Agricultural Irrigation Pump Engines Category for AQMD's FY 2003 Moyer Program. All information in RFP #P2004-04 and this Appendix apply. For additional detail regarding this program category, refer to CARB's 2003 Moyer Program Guidelines[1]. In the case of any conflict between CARB guidelines and AQMD criteria, the more stringent criteria will prevail. Also, it is the Applicant's responsibility to check with AQMD's Moyer Program web page for program clarifications, changes and updates. This page may be accessed by clicking the "Clean Air Technologies" link on AQMD's home page at www.aqmd.gov.

## INTRODUCTION

Stationary Internal Combustion (IC) engines used for agricultural purposes in California are widely utilized to power irrigation water pumps. For the purposes of AQMD's Carl Moyer Program (CMP), these engines are part of the off-road engine inventory because off-road engines are often utilized in these applications. However, due to the operating characteristics specific to stationary agricultural irrigation pump engines, they are evaluated separately from the off-road equipment category. Moyer Program funding is available for agricultural pump engines rated at 50 hp or above that provide voluntary reduction of NOx emissions by implementing alternative fuel engines.

Eligible stationary agricultural irrigation pump engine projects may include the following:

- New purchases with electric motors.
- Repower or retrofit with alternative fuel engines.
- Replacement with electric motors.

## PROGRAM GUIDELINES/CRITERIA

### Changes for 2003

Below are important changes to the Stationary Agricultural Irrigation Pump Engine category for 2003:

- Selected infrastructure costs for necessary equipment associated with the motor (e.g., control panel, motor leads, service pole with guy wire, connecting electric line) may be included in determining the grant amount awarded.

[1] Be sure to visit http://www.arb.ca.gov/msprog/moyer/moyer.htm for the latest approved CARB Moyer Program Guidelines.

- Diesel-to-diesel projects are NOT eligible in this program category.

- The cost-effectiveness threshold for the Stationary Agricultural Irrigation Pump Engine category was increased to $13,600 per ton of NOx reduced and the capital recovery factor was reduced to 3 percent.

**Project Eligibility Criteria**

In general, stationary agricultural irrigation pump engine projects qualifying for evaluation must meet the following criteria:

- An engine must be rated at 50 hp or greater, which is equivalent to an electric motor 37 kilowatts or greater.

- A new purchase of a 2003 or later model year agricultural irrigation pump must have an electric motor.

- A repower of an uncontrolled engine must be with:

  1) A new or OEM-rebuilt off-road alternative fuel spark-ignited (SI) engine tested to meet the current off-road NOx diesel engine standard shown in Table 5.1.

  2) A new electric motor.

- A repower of an emission-certified off-road engine must be with:

  1) A new or OEM-rebuilt off-road alternative fuel SI engine tested to meet the off-road NOx emission credit standards.

  2) A new electric motor.

- Engines must be tested using CARB test procedures for off-road engines.

- Electric motors must only replace IC engines that are fueled with diesel and the applicant must have documentation of payment to the local utility company for power installation. This requirement of documentation also applies to new installations.

- Eligible rebuilt or remanufactured engines are those offered by the OEM or by a non-OEM rebuilder that demonstrates to the ARB that the rebuilt engine and parts are functionally equivalent from an emissions and durability standpoint to the OEM engine and components being replaced.

- Reduced-emission engines or retrofit kits must be powered by alternative fuels certified for sale in California and must comply with durability and warranty requirements. Qualified engines include new CARB-certified engines or CARB-certified aftermarket part engine/control devices.

- NOx reductions obtained through this program must not be required by any existing regulations, memoranda of agreement or understanding, or any legally binding document.

- Funded projects must operate for a minimum of five years and the stationary agricultural irrigation pump engine must be registered with the local district throughout the specified life of the project.

- The cost of a non-reset hour-meter is eligible for projects that will use hours as the basis for calculating emission reductions (and subsequent project activity tracking).

- Projects must meet a cost-effectiveness criterion of $13,600 per ton of NOx reduced.

**Evaluation Methodology**

AQMD staff will evaluate all submitted proposals and make recommendations to the Governing Board for final selection of project(s) to be funded. Proposals will be evaluated based on the cost-effectiveness of NOx reduced on an equipment-by-equipment basis, as well as a project's "disproportionate impact" evaluation (discussed below). Be aware of the possibility that due to program priorities and/or funding limitations, project applicants may be offered only partial funding, and not all proposals that meet minimum cost-effectiveness criteria may be funded.

In compliance with AB 1390, Firebaugh, the FY 2003 Moyer Program requires that at least 50 percent of the funds be spent in areas that are disproportionately impacted by air pollution. CARB has issued broad goals and left the details of how to implement this requirement to each air agency. In the South Coast Air Quality Management District, the disproportionately impacted areas are defined by a weighted formula that includes poverty level, particulate matter (PM) exposure and toxic exposure. The process is described below:

1. All projects must qualify for the Moyer Program by meeting the cost-effectiveness limits established in the RFP.

2. All projects will be evaluated according to the following criteria to qualify for Disproportionate Impact funding:

a. Poverty Level: All projects in areas where at least 10 percent of the population falls below the Federal poverty level based on the year 2000 census data, will be eligible to be included in this category, and

b. PM Exposure: All projects in areas with the highest 15 percent of PM concentration will be eligible to be ranked in this category. The highest 15 percent of PM concentration is 46 micrograms per cubic meter and above, on an annual average, or

c. Toxic Exposure: All projects listed in the Multiple Air Toxics Exposure Study in the South Coast Air Basin (MATES II) report[2] as having a cancer risk of 1,000 in a million and above will be eligible to be ranked in this category.

Data for the poverty level and PM and toxic exposures were obtained from the U.S. Census, the 1998 AQMD monitoring data and Mates II study respectively.

3. Fifty percent of the $12.3 million available for this RFP will be allocated among proposals located in disproportionately impacted areas. If the funding for disproportionately impacted areas is not exhausted with the outlined methodology, then staff will return to the Governing Board for direction. If funding requests exceed 50 percent of the total available funding, then all qualified projects will be ranked based on their disproportionate impact. Each project will be assigned a score that is comprised of 40 percent for poverty level, and 30 percent each for PM and toxic exposures. Proposals with the highest scores will receive funding until 50 percent of the total funding is allocated.

   All the proposals not awarded under the fifty percent disproportionate impact funding analysis will then be ranked according to cost-effectiveness, with the most cost-effective project funded first and then in descending order for each funding category until the remainder of the Moyer Funds are exhausted. Some projects that exceed the cost-effectiveness ceiling may receive partial funding, depending on their rankings.

## Eligible Costs

Eligible project costs (i.e., costs for which Moyer funding is requested) are limited to the incremental cost of a project to implement the reduced emission

[2] Multiple Air Toxics Exposure Study in the South Coast Air Basin (MATES II), SCAQMD, March 2000.

technology. Please refer to the Project Types section below for additional detail. It is noteworthy that the cost of the hour-meter is eligible for inclusion in the capital cost of the engine for determining an award.

### Reporting and Monitoring

All participants in the Moyer Program are required to keep appropriate records during the full life of the project (minimum of 5 years). Records must be retained and updated throughout the project life and made available for AQMD inspection. The AQMD may conduct periodic reviews of each project's operating records to ensure that the engine is operated as stated in the project contract. Annual records must contain, at a minimum, actual hours of operation or estimated amount of fuel used per year. The type of records required to be maintained over the life of the project must be consistent with the calculation approach used, either one based on fuel consumption or hours of operation. Annual hours of operation are acceptable for an engine equipped with a non-reset hour-meter; otherwise fuel receipts must be provided to demonstrate fuel consumption. For electrification projects, the applicant must have documentation of payment to the local utility company for power installation.

## PROJECT TYPES

### New Equipment Purchase

Purchases of new agricultural irrigation pumps are eligible only if equipped with electric motors. For the purposes of determining emission reductions, this new zero-emission electric agricultural irrigation pump may be compared to a new pump powered by an off-road diesel engine certified to the current off-road NOx+NMHC emission standard. To determine the NOx emission factor to be used as the baseline in emission reduction calculations, apply the NOx fraction in Table 5.3 to the certified NOx+NMHC emission standard in Table 5.1.

### Repower with Emission-Certified Alternative Fuel Engines

An eligible stationary agricultural irrigation pump engine repower involves the replacement of an existing uncontrolled or emission-certified engine with a new or OEM-rebuilt off-road alternative fuel engine certified to the current applicable off-road NOx+NMHC emission standard. Only diesel-to-alternative fuel repowers for agricultural pump applications are eligible and the replacement engine in the 100 hp to 750 hp range must meet Tier 2 standards.

Purchases of new emission-certified diesel off-road engines to repower existing uncontrolled diesel engines are NOT eligible under AQMD's Moyer Program. Also, gasoline-to-diesel repower projects are <u>not</u> eligible.

Technology for diesel-to-alternative fuel repower is available. If the alternative fuel technology has not yet been emission tested, the applicant may conduct emission tests for large spark ignited (LSI) engines in accordance with CARB-approved test procedures for off-road engines and submit the test results along with the application. CARB LSI and U.S.EPA regulations establish testing programs and testing procedures. Emissions certification testing costs are not eligible for program funds.

**Replacement with Electric Motors**

Replacement of an uncontrolled engine with an electric motor is eligible. During the first year of the program, applications for electric motors were scarce. This was partly due to exclusion of infrastructure costs in determining the funding amount, which resulted in higher initial out-of-pocket costs to the applicant. In an electric pumping application, peripheral equipment is needed to supply electricity to the motor. The installed cost of a new certified diesel engine is comparable to the installed cost for an electric motor plus its necessary supporting components. Districts and utility companies have indicated that many diesel pump engines are situated next to existing electric lines, so no line extension would be needed. Considering the air quality benefits of electric motors, selected infrastructure costs for necessary equipment associated with the motor (e.g., control panel, motor leads, service pole with guy wire, connecting electric line) are eligible to be included in determining the grant amount awarded.

It is noteworthy that some utility companies offer monetary line extension credits for remotely located irrigation pumps. Where a credit applies, the customer is responsible for the cost of the line extension (generally charged on a per foot basis) beyond what is covered by the credit.

**Retrofits**

Retrofit involves modifications to the engine and/or fuel system such that the retrofitted engine does not have the same specifications as the original engine. The most straightforward retrofit projects are those that can be accomplished at the time of engine rebuild. This might entail upgrading certain engine and/or fuel system components to result in lower emission configuration. Moyer Program funding is only provided for alternative fuel retrofits. The retrofit system must comply with established durability and warranty requirements.

**Auxiliary Engine Technologies for Reduced Emission Stabilization in Alternative Fuel Pump Engines**

Recent in-field testing, spot checks, and follow-up annual tests conducted by the Santa Barbara APCD revealed significant variation in NOx levels over time relative to initial setup conditions on some alternative fuel (natural gas/propane)

stationary agricultural water pump engines funded by the Moyer Program. Because of varying operating conditions for these engines, NOx emissions can drop dramatically at lean fuel mixtures. Auxiliary engine technologies such as closed-loop air to fuel ratio controllers (AFCs) are currently available to help maintain low emission levels over the engine project life. CARB requires that non-certified alternative fuel off-road agricultural engines be outfitted with 3-way catalytic converters, but no requirement exists for any type of auxiliary control such as AFC's.

In practice, three-way catalysts are used with AFCs to give satisfactory catalyst operation for efficient NOx control. However, agricultural engines are exempt from permits and AFC's are uncommon for farming operations. Auxiliary engine technology such as AFC's establish efficient NOx control year-round, save fuel, extend catalyst life, and compensate for natural gas fuel quality ( i.e., higher-than-normal BTU natural gas or hot gas). For these reasons, CARB and local districts will evaluate on a case-by-case basis the possible benefits offered by requiring that alternative fuel engines be equipped with a closed-loop AFC and 3-way catalytic converter, as proposed by the engine manufacturer/vendor/grantee. Additional hardware requirements for natural gas or propane engines for which this technology can be applied (AFC + 3-way catalyst) ensure that emission reductions paid for by program funds are fully realized.

## EMISSION REDUCTION AND COST-EFFECTIVENESS

### Emission Standards and Default Factors

Table 5.1 below lists both the CARB and U.S.EPA standards applicable to this program category. The combination of CARB and U.S.EPA emission standards means that all of today's new off-road diesel cycle engines greater than 100 hp and smaller than 750 hp have to be certified to meet Tier 2 NOx+NMHC emission standards of 4.9 or 4.8 g/bhp-hr, depending on size. Starting in January 1, 2004, the Tier 2 requirements extend to engines in the less than 100hp size range.

**Table 5.1 – CARB and U.S.EPA Exhaust Emission Standards for New Off-Road Diesel Engines > 50 hp**

| (g/bhp-hr) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Maximum Rated Power (hp) | Tier | Model Year | NOx | HC | NOx+NMHC | CO | PM |
| 50-<100 | Tier 1 | 1998-2003 | 6.9 | — | — | — | — |
| | Tier 2 | 2004-2007 | — | — | 5.6 | 3.7 | .3 |
| | Tier 3 | 2008 and later | — | — | 3.5 | 3.7 | (a) |
| 100-<175 | Tier 1 | 1997-2002 | 6.9 | — | — | — | — |
| | Tier 2 | 2003-2006 | — | — | 4.9 | 3.7 | .22 |
| | Tier 3 | 2007 and later | — | — | 3.0 | 2.6 | (a) |
| 175-<300 | Tier 1 | 1996-2002 | 6.9 | 1.0 | — | 8.5 | 0.40 |
| | Tier 2 | 2003-2005 | — | — | 4.9 | 2.6 | .15 |
| | Tier 3 | 2006 and later | — | — | 3.0 | 2.6 | (a) |
| 300-<600 | Tier 1 | 1996-2000 | 6.9 | 1.0 | — | 8.5 | .40 |
| | Tier 2 | 2001-2004 | — | — | 4.8 | 2.6 | .15 |
| | Tier 3 | 2005 and later | — | — | 3.0 | 2.6 | (a) |
| 600-<750 | Tier 1 | 1996-2001 | 6.9 | 1.0 | — | 8.5 | .40 |
| | Tier 2 | 2002-2004 | — | — | 4.8 | 2.6 | .15 |
| | Tier 3 | 2005 and later | — | — | 3.0 | 2.6 | (a) |
| >750 | Tier 1 | 2000-2005 | 6.9 | 1.0 | — | 8.5 | .4 |
| | Tier 2 | 2006 and later | — | — | 4.8 | 2.6 | .15 |

(a) PM emission standards have not been specified.

At the option of the manufacturer, emission-certified engines that are model year 1996 and newer can be certified to one of the applicable NOx emission credit standards listed in Table 5.2, below.

**Table 5.2 – Optional NOx Emission Credit Standards**

| Engine Model Year | Engine Horsepower Rating (bhp) | Qualifying NOx+NMHC Level (g/bhp-hr) |
|---|---|---|
| 1996-2000 | 50-750 | 4.5 |
| 2000+ | 750+ | 4.5 |
| 2001+ | 50-750 | 4.0 |

As stated earlier, eligibility is based on the cost-effectiveness of NOx reductions, without the NMHC portion of the emissions. To determine NOx emissions, the certification NOx+NMHC emission standard for an engine is multiplied by the appropriate NOx fraction provided in Table 5.3, below.

**Table 5.3 – NOx Fraction Default Values**

| Diesel Engines | Alternative Fuel Engines |
|---|---|
| 0.95 | 0.80 |

In absence of manufacturer "guaranteed" emission factors, Table 5.4 provides default baseline NOx emission levels for pre-1996 model year diesel engines. These reflect the recently adopted OFFROAD emission inventory model for off-road large compression ignition engines greater than or equal to 25 hp.

The applicant continues to have the option of testing the baseline (uncontrolled) engine using a CARB-approved test procedure to determine in-use emissions.

**Table 5.4 – Baseline NOx and PM Emission Factors for Uncontrolled Off-Road HD Diesel Engines (g/bhp-hr)**

| **Horsepower** | **Engine Model Year** | **NOX** (g/bhp-hr) | **PM** (g/bhp-hr) |
|---|---|---|---|
| 50-120 | Pre-1988 | 13 | 0.84 |
| 50-120 | 1988-1997 | 8.75 | 0.69 |
| 121-175 | Pre-1970 | 14 | 0.77 |
| | 1970-1971 | 13 | 0.66 |
| | 1972-1979 | 12 | 0.55 |
| | 1980-1987 | 11 | 0.55 |
| | 1988-1996 | 8.17 | 0.38 |
| 176-250 | Pre-1970 | 14 | 0.77 |
| | 1970-1971 | 13 | 0.66 |
| | 1972-1979 | 12 | 0.55 |
| | 1980-1987 | 11 | 0.55 |
| | 1988-1995 | 8.17 | 0.38 |
| 251-750 | Pre-1970 | 14 | 0.74 |
| | 1970-1971 | 13 | 0.63 |
| | 1972-1979 | 12 | 0.53 |
| | 1980-1987 | 11 | 0.53 |
| | 1988-1995 | 8.17 | 0.38 |
| >750 | Pre-1970 | 14 | 0.74 |
| | 1970-1971 | 13 | 0.63 |
| | 1972-1979 | 12 | 0.53 |
| | 1980-1987 | 11 | 0.53 |
| | 1988-1999 | 8.17 | 0.38 |

California Fuel Correction Factor

The use of California's diesel fuel since 1993 (0.05 percent sulfur content by weight and 10 percent aromatic content by volume) would result in fewer NOx and PM emissions from diesel engines compared to the base emission rates. Base emission rates for diesel engines, as embodied in the ARB's OFFROAD emission inventory model, were derived from test data using either federal diesel fuel (0.05 percent sulfur content by weight) or pre-1993 diesel fuel. Federal diesel fuel is also used for new engine certification to comply with required emission standards. Thus, a fuel correction factor needs to be applied to the base emission rate, for both uncontrolled and emission-certified engines, to more accurately reflect the emissions from diesel engines when those engines are operated using California diesel fuel. Table 5.5 shows the CA-FCFs to be used for off-road diesel engines.

**Table 5.5 – California Fuel Correction Factors (Off-Road Diesel Engines)**

| Model Year | NOx | PM |
|---|---|---|
| Pre – Tier I | 0.94 | 0.80 |
| Tier I + | 0.87 | 0.90 |

Load Factor

A load factor is an indicator of the amount of work required, on average, from an engine for a particular application and is given as a fraction of the engine horsepower rating. The default load factor for a agricultural irrigation pump engine is 0.65. The load factor for the reduced-emission engine shall be based on the ratio of the baseline and reduced-emission engine horsepowers as illustrated in the examples below.

**Table 5.6 – Default Load Factor for Stationary Agricultural Irrigation Pump Engines**

| | |
|---|---|
| Default Load Factor | 0.65 |

Energy Consumption Factor

When annual fuel consumption is used, an energy consumption factor should be utilized to convert g/bhp-hr to gm/gallon of fuel consumed. The default energy consumption factor for agricultural pump engines is 17.56 bhp-hr/gal of fuel.

**Table 5.7 – Default Energy Consumption Factor for Stationary Agricultural Irrigation Pump Engines**

| | |
|---|---|
| Default Energy Consumption Factor | 17.56 bhp-hr/gal |

## Emission Reduction Calculation Discussion

In general, the emission reduction benefit of a project represents the difference in the emission level of an existing baseline with its reduced-emission replacement or retrofit engine (i.e., alternative fuel or electric motor). In situations where the model year of the equipment and the model year of the existing engine are different, the model year of the engine will be used to determine the baseline emission factor for emission reduction calculations.

The emission level is calculated by multiplying an emission factor, a conversion factor, and an activity level. Because the conversion factor and the activity level can be different for the baseline and replacement engine, the emission levels should be calculated prior to determining the difference in emissions. For a stationary agricultural irrigation pump, the activity level is typically expressed as annual hours of operation or annual fuel consumption. Thus, the type of records required to be maintained over the life of the project must be consistent with the calculation approach used, either based on hours of operation or fuel consumption.

Hour-Based Emission Reduction Calculation

If annual hours of operation are the basis for determining emission benefits, the applicable calculation is the horsepower of the engine multiplied by load factor and activity level. Number of hours the equipment is in operation must be based on an hour-meter.

*Annual NOx Reductions (tons/year) = [(NOx Emission Factor * Load Factor * Horsepower)$_{Existing}$ – (NOx Emission Factor * Load Factor * Horsepower)$_{Replacement}$] * Annual Hours of Operation * (ton/907,200 grams)*

Fuel-Based Emission Reduction Calculation

If annual fuel consumption is used to track activity, an energy consumption factor is needed to convert the engine emission factor given in gm/bhp-hr to gm/gallon of fuel used. **The default energy consumption factor for agricultural pump engines is 17.56 bhp-hr/gal of fuel.**

While actual fuel receipts are required to support the annual fuel consumption of the existing baseline engine, the annual fuel consumption of the replacement reduced-emission engine is an estimate proportional to the change in the energy fuel consumption factor.

For example, a reduced-emission engine having an energy content factor of 20 bhp-hr/gal and replacing a baseline engine, which uses 3,696 gallons/year and has an energy content factor of 17.56 bhp-hr/gal, would have an estimated annual equivalent fuel consumption of 3,245[3] gallons/year. Future fuel receipts or equivalent documentation must be submitted throughout the project life for verification of these estimates.

*Annual NOx Reductions (tons/year) = [(NOx Emission Factor * Energy Consumption Factor * Annual Fuel Consumption)* $_{Existing}$ *– (NOx Emission Factor * Energy Consumption Factor * Annual Fuel Consumption))* $_{Replacement}$*] * (ton/907,200 grams)*

Please refer to Appendix 2: Off-Road Engines and Equipment for additional discussion on the energy consumption factor.

**Cost-Effectiveness Calculation Discussion**

Cost-effectiveness is based on the incremental capital cost, the expected life of the project, the capital recovery factor (CRF) and estimated annual NOx reductions in the AQMD. The amount of incentive funds for the incremental costs of the cleaner technology depends on emission reductions and the C/E limit of $13,600 per ton of NOx reduced.

The portion of the cost for a stationary agricultural irrigation pump engine to be funded by the Moyer Program is the difference between the total cost of purchasing and installing the replacement engine (a new or newer emission-certified engine or a new electric motor) and the total cost of rebuilding the existing engine to its original specifications. In addition, the cost to install non-reset hour-meters and selected infrastructure costs for necessary equipment associated with the motor (e.g., control panel, motor leads, service pole with guy wire, connecting electric line) may be included in determining the grant amount awarded.

Only Moyer Program funds are to be used in determining cost-effectiveness[4]. The one-time incentive grant amount is to be amortized over the expected project life (at least five years) using a discount rate of 3 percent.

[3] (17.56 / 20) * 3,696 = 3,245

[4] Unless the AQMD "buy down" the cost of the project by adding additional funding, in which case the total grant funding amount should be used for the cost-effectiveness calculation.

$$\textit{Capital Recovery Factor (CRF)} = [(1 + i)^n (i)] / [(1 + i)^n - 1]$$

where,

$i$ = discount rate (3%)
$n$ = project life (at least five years)

Table 5.8 lists the CRF for different project lives based on a discount rate of 3 percent. Cost-effectiveness for a project is determined by dividing the total annualized cost by the total annual NOx emission reductions.

**Table 5.8 – Capital Recovery Factors (CRF) for Various Project Lives At 3 Percent Discount Rate.**

| Project Life | CRF |
|---|---|
| 5 | 0.218 |
| 6 | 0.185 |
| 7 | 0.161 |
| 8 | 0.142 |
| 9 | 0.128 |
| 10 | 0.117 |
| 11 | 0.108 |
| 12 | 0.100 |
| 13 | 0.094 |
| 14 | 0.089 |
| 15 | 0.084 |
| 16 | 0.080 |
| 17 | 0.076 |
| 18 | 0.073 |
| 19 | 0.070 |
| 20 | 0.067 |

The applicant is encouraged to review Appendix 2 – Off-Road Engines and Equipment for a more detailed discussion regarding emission reduction calculation methodologies. Also, please refer to the examples below for sample calculations.

## Project Life

As discussed above, a key parameter in the determination of a project's emission reduction benefit is its project life. The acceptable maximum life for calculating

the project benefits of stationary agricultural irrigation pump engine projects is summarized below in Table 5.9.

**Table 5.9 – Maximum Project Life for Irrigation Pump Projects**

| Project Type | Default without Documentation | Default with Documentation |
|---|---|---|
| New locomotive | 20 years | 30 years |
| Repower or retrofit locomotive | 20 years | 30 years |

Project life beyond the "default without documentation" limits may be submitted for approval by CARB.

**Example One – Agricultural Irrigation Pump Repower to CNG (Hour-Based)**

A farmer plans to replace a 1980 model year diesel engine rated at 120 hp used in an irrigation water pump with a new, certified off-road CNG engine rated at 150 hp during the normal rebuild period. In this case, the cost of the new, emission-certified CNG engine is $45,000 whereas the cost to rebuild the existing engine would be $6,000. The cost of a non-reset hour meter is $500. The old engine operated 2,000 hours annually. The project life is 7 years.

Emission Reduction Calculation

**Baseline NOx Emissions:** 13.0 g/bhp-hr (Table 5.4)
**Baseline Horsepower:** 120 hp
**Baseline Load Factor:** 0.65 (Table 5.6)
**Reduced NOx+NMHC Emissions:** 4.9 g/bhp-hr (Table 5.1)
**Reduced NOx Emissions**: 0.8 * 4.9 g/bhp-hr = 3.92 g/bhp-hr (see Table 5.3)
**Replacement Horsepower:** 150 hp
**Reduced Load Factor:** 120 hp / 150 hp * 0.65 = 0.52
**Annual Operating Hours:** 2,000 hours/year
**Conversion factor** 1 ton = 907,200 grams

Estimated annual NOx reductions are:

[(13.0 g/bhp-hr * 120 hp * 0.65) – (3.92 g/bhp-hr * 150 hp * 0.52)] * 2,000 hrs/yr * ton/907,200 g =

**1.56 ton/year NO emissions reduced**

Cost and Cost-Effectiveness Calculations

The annualized cost is based on the incremental project costs funded by the CMP, the expected life of the project (5 years at a minimum), and the interest rate (3%) used to amortize the project cost over the project life.

**Incremental Capital Cost** = $ 45,500 - $ 6,000 = $ 9,500
**Max. Amount Funded** = $ 39,500
**Capital Recovery (Table 5.8)** = 0.161
**Annualized cost** = $ 39,500 * 0.161 = $ 6,359.5/year
**Cost-Effectiveness** = ($ 6,359.5/year) / (1.56 tons/year) = **$ 4,077/ton NOx reduced**

The project meets the cost-effectiveness limit of $13,600 per ton NOx reduced. This project qualifies for the maximum amount of requested funding ($39,500).

## Example Two – Agricultural Irrigation Pump Repower (Fuel-Based)

Consider a similar example where an uncontrolled diesel engine (1980, 13 g/bhp-hr NOx) used to power an irrigation water pump is replaced with a new, certified off-road CNG engine (150 hp, 4.9 g/bhp-hr NOx+NMHC). The energy consumption factor for the uncontrolled engine is unknown while the energy consumption factor for the new engine is 19 bhp-hr/gal. The cost of the new, emission-certified CNG engine is $45,000 whereas the cost to purchase a rebuilt engine is $6,000. The farmer lists in the application that the new engine will use 4,600 gallons of fuel annually for a project life of 7 years. Since this farmer lists fuel consumption, a *non-reset hour meter is not needed*. The emission reduction and cost effectiveness for this project are calculated as follows:

### Emission Reduction Calculation

**Baseline NOx Emissions:** 13.0 g/bhp-hr (Table 5.4)
**Baseline Energy Consumption Factor:** 17.56 hp-hr/gal (Table 5.7)
**Baseline Annual Fuel Consumption:** 4,600 gallons/year
**New Engine NOx+NMHC Emissions:** 4.9 g/hp-hr (Table 5.1)
**New Engine NOx Emissions:** 0.8*4.9 = 3.92 g/bhp-hr (see Table 5.3)
**New Engine Energy Consumption Factor:** 19 hp-hr/gal
**New Engine Annual Fuel Consumption:** (17.56 /19)hp-hr/gal * 4,600 gal/yr = 4,251 gal/yr
**Conversion Factor:** 1 ton=907,200 grams

Estimated annual NOx reductions are:

[(13.0 g/bhp-hr * 17.56 hp-hr/gal * 4,600 gal/yr) – (3.92 g/bhp-hr * 19 hp-hr/gal * 4,251 gal/yr)] * ton/907,200 g = **0.81 tons/yr of NOx emissions reduced**

### Cost and Cost-Effectiveness Calculations

The annualized cost is based on the incremental project costs funded by the CMP, the expected life of the project (7 years in this example), and the interest rate (3%t) used to amortize the project cost over the project life. Funding is determined as follows:

**Incremental Capital Cost** = $ 45,000 - $ 6,000 = $ 39,000
**Max. Amount Funded** = $ 39,000
**Capital Recovery (Table 5.8)** = 0.161

**Annualized cost** = $ 39,000 * 0.161 = $ 6,279/year
**Cost-Effectiveness** = ($ 6,279/year)/(0.81 tons/year) = **$ 7,766/ton of NOx reduced**

The project meets the cost-effectiveness limit of $13,600 per ton NOx reduced. This project qualifies for the maximum amount of grant funds ($39,000).

## Example Three – Agricultural Irrigation Pump Electrification

A farmer applies for a Moyer Program grant for the purchase of an electric motor (150 hp) to replace an uncontrolled diesel engine (208 hp, 1980, 11 g/bhp-hr NOx) used to power an irrigation water pump. There is currently an electric power grid in the immediate vicinity of the pump and no electric line extension is needed. The installed cost of the new electric motor, control panel, motor leads, dropping a power line, and setting up a circuit breaker is $14,602 whereas the cost to rebuild the existing engine is $5,500. The cost of a non-reset hour meter is $300. The new engine will operate 2,000 hours annually for a project life of 7 years.

### Emission Reduction Calculation

| | |
|---|---|
| **Existing Engine NOx Emission Factor:** | 11.0 g/bhp-hr |
| **Replacement Motor NOx+NMHC Emission Factor:** | 0 g/bhp-hr |
| **Baseline Load Factor:** | 0.65 |
| **Baseline Horsepower:** | 208 hp |
| **Reduced Horsepower:** | 150 hp |
| **Reduced Load Factor:** | 208 hp / 150 hp * 0.65 = 0.9 |
| **Annual Hours of Operation:** | 2,000 hours |

Estimated annual NOx reductions are:

[(11.0 g/bhp-hr * 0.65 * 208 hp) – (0 g/bhp-hr * 0.9 * 150 hp)] * 2,000 hrs/yr * ton/907,200 g = 3.28 **tons/year NOx emissions reduced**

### Cost and Cost-Effectiveness Calculations

The annualized cost is based on the incremental project costs funded by the CMP, the expected life of the project (7 years in this example), and the interest rate (3%) used to amortize the project cost over the project life.

**Incremental Capital Cost** = $14,602 - $5,500 = $9,102
**Capital Recovery (Table 5.8)** = 0.161
**Annualized Cost** = (0.161) * ($9,102) = $1,461/yr
**Cost-Effectiveness** = ($1,461/yr) / (3.28 tons/yr) = **$445/ton**

The project meets the cost-effectiveness limit of $13,600/ton NOx reduced. This project qualifies for the maximum amount of grant funds ($9,102).

**Example Four – Agricultural Irrigation Pump "Diesel-to-Natural Gas" Repower**

A farmer plans to replace a model year 1980 diesel engine rated at 165 hp used to power an irrigation water pump. The farmer is replacing the existing uncontrolled engine (11 g/bhp-hr NOx) with a new, optionally certified off-road natural gas engine rated at 150 hp (4.5 g/bhp-hr NOx+NMHC) during the normal rebuild period. The cost of the off-road natural gas engine is $23,500 whereas the cost to purchase a rebuilt diesel engine is $5,500. The cost of a non-reset hour meter is $300. The new engine will operate 2,000 hours annually, for a project life of seven years.

Emission Reduction Calculation

| | |
|---|---|
| **Baseline NOx Emissions =** | 11.0 g/bhp-hr (Table 5.4) |
| **Baseline Horsepower =** | 165 horsepower |
| **Baseline Load Factor =** | 0.65 (Table 5.6) |
| **Reduced NOx+NMHC Emissions =** | 4.0 g/bhp-hr (Table 5.2) |
| **Reduced NOx Emissions**: | 0.8 * 4.0 g/bhp-hr = 3.2 g/bhp-hr (see Table 5.3) |
| | |
| **Replacement Engine Horsepower =** | 150 horsepower |
| **Replacement Engine Load Factor =** | (165hp / 150hp) * 0.65 = 0.72 |
| **Annual Operating Hours=** | 2,000 hours/year |
| **Conversion Factor=** | 1 ton = 907,200 grams |

Estimated annual NOx reductions are:

[(11.0 g/bhp-hr * 165 hp * 0.65) – (3.2 g/bhp-hr * 150 hp * 0.72)] * 2,000 hours/year * ton/907,200 g = **1.84 ton/year NOx emissions reduced**

Cost-Effectiveness Calculations

| | |
|---|---|
| **Incremental Capital Cost** | = $ 23,800 - $ 5,500 = $ 18,300 |
| **Max. Amount Funded** | = $ 18,300 |
| **Capital Recovery (Table 5.8)** | = 0.161 |
| **Annualized cost** | = $18,300 * 0.161 = $ 2,937/year |
| **Cost-Effectiveness** | = ($ 2,937/year)/(1.84 tons/year) = **$ 1,782/ton** |

The project meets the cost-effectiveness limit of $13,600 per ton NOx reduced. This project qualifies for the maximum amount of grant funds ($18,300).

## Carl Moyer Memorial Air Standards Attainment Program
### STATIONARY AGRICULTURAL IRRIGATION PUMP ENGINE APPLICATION

Please provide all information requested regarding your proposed purchase and application. Additional information may be requested during the review process. Applicant acknowledges that award of cash incentive is subject to AQMD approval and must meet the minimum eligibility criteria within the project category. **Please Print or Type**

| **APPLICANT INFORMATION:** | | |
|---|---|---|
| Organization/Company Name: | | |
| Business Type: | | |
| Project Name: | | |
| Street/Mailing Address: | | |
| City: | State: | Zip Code: |
| Project Location Address: | | |
| City: | State: | Zip Code: |
| Contact Name: | | |
| Phone: ( ) | Fax: ( ) | |
| E-mail: | | |
| Number of Stationary Agricultural Engines: | | |
| Number of Stationary Agricultural Engines to be Replaced/Retrofitted: | | |

**I hereby certify that all information provided in this application and any attachments are true and correct.**

| Total Number of Engines Requested for Funding: | Total Funding Request: |
|---|---|
| Printed Name of Responsible Party: | Title: |
| Signature of Responsible Party: | Date: |

## CHECK LIST FOR APPLICATION ITEMS

**Be sure the following items are included with your application submittal. Check each applicable item below to indicate inclusion of material.**

- ❑ Completed Application Forms
- ❑ Checklists for Application Items and Eligibility Criteria
- ❑ Project cost information (as described in the RFP), which shall include vendor quotes or other documentation substantiating cost data provided in Application.
- ❑ Contracting Statements (Applications are not eligible without this form.)
    - ❑ Statement of Understanding for Work Statement and Deliverables
    - ❑ Conflict of Interest Statement (as described in the RFP)
    - ❑ Third-Party Application Submittal Authorization (Only required if application is submitted by someone other than the vehicle/equipment owner.)
- ❑ Co-funding information (if applicable).
- ❑ Certifications and Representations
- ❑ Other (attach explanation)

If you have any questions regarding the application process for Stationary Agricultural Irrigation Pump Engine projects, please contact Connie Day, Science & Technology Advancement at (909) 396-3055 by phone, or (909) 396-3252 by fax.

## REMINDER

**Due Date** - The proposer shall submit **six (6) complete copies of the proposal** in a sealed envelope, plainly marked in the upper left-hand corner with the name and address of the proposer and the words "Request for Proposals #P2004-04." All proposals are due no later than 5:00 p.m., on Friday, October 10, 2003. Postmarks are not accepted. **Faxed or e-mailed proposals will not be accepted**. Proposals must be directed to:

Procurement Unit
South Coast Air Quality Management District
21865 East Copley Drive
Diamond Bar, CA 91765

**CONTRACTING STATEMENTS (All Are Required)**

## 1. Statement of Understanding for Work Statement and Deliverables

In order to minimize the effort required to complete a Moyer Program Application, AQMD does not require submittal of a Work Statement or Deliverables Summary with the Application. However, the undersigned confirms full understanding that, if awarded funding under the Carl Moyer Program, development and submittal of the detailed work statement, with deliverables and schedule, is a requirement of the contracting process. Recommended projects will not receive funding without these documents. Full details of the Work Statement and Deliverables requirements are detailed in RFP #P2004-04. In addition, Baseline and Reduced Emission Vehicle Serial/VIN information must be provided at contract start. By signing below, the applicant acknowledges these requirements.

## 2. Conflict of Interest Statement

Please address any potential conflicts of interest with other clients affected by actions performed by the firm on behalf of the AQMD in the form of a Conflict of Interest Statement. Although the proposer will not be automatically disqualified by reason of work performed for such firms, the AQMD reserves the right to consider the nature and extent of such work in evaluating the proposal. Conflicts of interest will be screened on a case-by-case basis by the AQMD District Counsel's Office. Conflict of interest provisions of the state law, including the Political Reform Act, may apply to work performed pursuant to this contract. Please provide a Conflict of Interest Statement below. If additional room is necessary, please attach extra pages to this sheet.

## 3. Third-Party Application (Circle One: Applicable Not Applicable)

Applicants who are submitting on behalf of a vehicle/equipment owner must provide authorization from the vehicle/equipment owner to act on their behalf for this application process. This authorization shall be provided in the form of a "Letter of Exclusive Authorization", to be attached to this sheet. In addition, the vehicle/equipment owner shall enter into a contract with its authorized applicant, who will sign a contract with AQMD for fulfilling all contract obligations.

| | |
|---|---|
| Organization: | |
| Printed Name of Responsible Party: | Title: |
| Signature of Responsible Party: | Date: |

## CHECK LIST FOR ELIGIBILITY CRITERIA

**Please check each applicable box to indicate eligibility of proposed stationary agricultural engine technology.**

❑ The stationary agricultural engine is 50 horsepower or greater.

**Check applicable categories below:**

The reduced-emission engine/technology:

- ❑ is certified for sale in California;
- ❑ meets the minimum NOx emission reduction requirement, with no increase in particulate matter emissions, compared to the applicable standards or emission levels for that engine year and type of application through:
  - ❑ California Air Resources Board (CARB) certification testing, or
  - ❑ U.S. EPA certification testing, or
  - ❑ Emission testing at a laboratory approved by the U.S. EPA or CARB;

***and***

A. For agricultural pump repower projects:

- ❑ The replacement engine must be alternative fuel, certified to the current emission standards applicable for that engine, and is at least 15 percent lower than the NOx, or NOx+NMHC, emission level of the engine being replaced, or
- ❑ Is replaced with an electric motor

B. For retrofit kit or add-on projects:

- ❑ The retrofit converts the diesel pump to alternative fuel operation and achieves at least a 15 percent reduction of NOx, or NOx+NMHC, emissions, and no increase in particulate matter emissions, compared to the applicable standards or emission levels for that engine year.
- ❑ The retrofit technology is warranted by retrofit manufacturer and/or authorized dealer.

❑ The purchase is not required by any local, state, or federal rule or regulation, Memorandum of Understanding (MOU) or Memorandum of Agreement (MOA), or used to comply with any such rule or regulation, MOU or MOA.

**STATIONARY AGRICULTURAL IRRIGATION PUMP ENGINE APPLICATION**
**ENGINE REPOWER OR RETROFIT INFORMATION**

For each engine that you plan to repower/retrofit, complete and attach the appropriate form.

| |
|---|
| 1. Company Name: |
| 2. Please Check One:<br>□ **Repowering** a stationary agricultural engine with a new alternative fuel engine.<br>□ **Retrofitting** a stationary agricultural engine with alternative fuel technology. |

| **A. Information About New Reduced-Emission or Retrofitted Engine:** | | |
|---|---|---|
| 3. Engine Type: □ Compression Ignition □ Spark Ignition | | |
| 4. Engine Manufacturer: | | |
| 5. Engine Model: | 6. Engine Series: | 7. Engine Serial Number: |
| 8. Manufacturer's Maximum Rated Brake Horsepower Rating: | 9. Year of Manufacture: | |
| 10. Primary Fuel: □ Diesel □ Natural Gas □ Other If "Other," specify fuel: | | |
| 11. Estimated Total Annual Hours of Operation: | 12. Estimated Engine Operating Load (if known): | |
| 13. Estimated Annual Fuel Consumption (include units): | | |
| 14. Primary Function of Engine (Irrigation pump): | | |
| 15. Is there any seasonality to the use of the engine? YES/NO If Yes, please explain: | | |
| 16. Estimated Engine Life: | 17. Estimated Rebuild/Replacement Schedule: | |
| 18. Cost of Rebuilding/Replacing Engine: | 19. Cost of Rebuilding/Replacing Engine with Low Emission Technology: | |
| 20. Certified NOx Emission Standard: | 21. Certified PM[5] Emission Standard: | |
| 22. Indicate certified engine United State Environmental Protection Agency Standardized Engine Family Name: | | |
| 23. Indicate the method of record keeping that will be used:<br>□ Annual fuel use records<br>□ Annual records of hours of operation as verified by non-reset hour meter installed on the engine. | | |

[5] PM emission factors are available in RFP #P2004-04 in the Particulate Matter Information Section.

**STATIONARY AGRICULTURAL IRRIGATION PUMP ENGINE APPLICATION**
**ENGINE REPOWER OR RETROFIT INFORMATION, Cont'd.**

| **B. Information About Existing Engine to be Repowered or Retrofit:** | | |
|---|---|---|
| 1. Engine Type: □ Compression Ignition □ Spark Ignition | | |
| 2. Engine Manufacturer: | | |
| 3. Engine Model: | 4. Engine Series: | 5. Engine Serial Number: |
| 6. Manufacturer's Maximum Rated Brake Horsepower Rating: | 7. Year of Manufacture: | |
| 8. Primary Fuel: □ Diesel □ Natural Gas □ Other If "Other," specify fuel: | | |
| 9. Average Engine Life: | 10. Typical Rebuild/Replacement Schedule: | |
| 11. Cost of Rebuilding/Replacing Engine: | | |
| 12. Baseline NOx Emission Standard: | 13. Baseline PM Emission Standard: | |
| 14. Indicate certified engine United State Environmental Protection Agency or Air Resources Board Standardized Engine Family Name (if applicable): | | |

**STATIONARY AGRICULTURAL IRRIGATION PUMP ENGINE APPLICATION**
**ENGINE REPOWER OR RETROFIT INFORMATION, Cont'd.**

| **C. General Information About the Installer:** | | |
|---|---|---|
| **Please complete the information below for engine repower (replacement)** | | |
| 1. Engine Installer: | | |
| 2. Street Address: | | |
| City | State: | Zip Code: |
| 3. Contact Name: | | |
| Phone: ( ) | Fax: ( ) | |
| **Please complete the information below for engine retrofit.** | | |
| 4. Retrofit Manufacturer: | | |
| 5. Retrofit Installer: | | |
| 6. Installer Street Address: | | |
| City | State: | Zip Code: |
| 7. Contact Name: | | |
| Phone: ( ) | Fax: ( ) | |
| 8. Retrofit Kit Number: | | |
| 9. Description of Retrofit Technology: | | |

## STATIONARY AGRICULTURAL IRRIGATION PUMP ENGINE APPLICATION

**New Pump with Electric Motor**
**-or-**
**Electric Motor Replacement Information**

For each engine that you plan to replace or purchase, complete and attach the appropriate form.

| |
|---|
| 1. Company Name: |
| 2. Please Check One:<br><br>□ Replacing a stationary agricultural engine with an electric motor.<br>□ Purchasing a new agricultural pump powered by an electric motor. |

| **A. Information About Existing Engine to be Replaced:** | | |
|---|---|---|
| 3. Engine Type: □ Compression Ignition □ Spark Ignition | | |
| 4. Engine Manufacturer: | | |
| 5. Engine Model: | 6. Engine Series: | 7. Engine Serial Number: |
| 8. Manufacturer's Maximum Rated Brake Horsepower Rating: | 9. Year of Manufacturer: | |
| 10. Primary Fuel: □ Diesel □ Natural Gas □ Other If "Other," specify fuel: | | |
| 11. Estimated Total Annual Hours of Operation: | 12. Estimated Engine Operating Load: | |
| 13. Estimated Annual Fuel Consumption (include units): | | |
| 14. Primary Function of Engine (e.g., irrigation pump): | | |
| 15. Is there any seasonality to the use of the engine? YES/NO If Yes, please explain: | | |
| 16. Average Engine Life: | 17. Typical Rebuild/Replacement Schedule: | |
| 18. Cost of Rebuilding/Replacing Engine: | 19. Cost of Rebuilding/Replacing Engine with Low Emission Technology: | |
| 20. Baseline NOx, or NOx+NMHC, Emission Standard: | 21. Baseline PM Emission Standard: | |
| 22. Indicate certified engine United State Environmental Protection Agency or Air Resources Board Standardized Engine Family Name (if applicable): | | |

## STATIONARY AGRICULTURAL IRRIGATION PUMP ENGINE APPLICATION

**New Pump with Electric Motor**
**-or-**
**Electric Motor Replacement Information, Cont'd.**

| **B. Information About New Electric Motor:** | |
|---|---|
| 1. Electric Motor Manufacturer: | |
| 2. Electric Motor Model: | 3. Electric Motor Serial Number: |
| 4. Estimated Total Annual Hours of Operation: | |
| 5. Estimated Annual Energy Usage (include units): | |
| 6. Estimated Electric Motor Life: | 7. Estimated Rebuild/Replacement Schedule: |
| 8. Cost of Replacing with Electric Motor: | |
| 9. Indicate the method of record keeping that will be used:<br><br>□ Annual power consumption records<br>□ Annual records of hours of operation as verified by non-reset hour meter installed on the electric motor | |

| **C. General Information About the Installer:** | | |
|---|---|---|
| 1. Electric Motor Installer: | | |
| 2. Street Address: | | |
| City | State: | Zip Code: |
| 3. Contact name: | | |
| Phone: ( ) | Fax: ( ) | |